Claims

What is claimed is:

1. An apparatus for use in an industrial process for measuring a velocity of a fluid moving in a pipe, comprising:

a first filter which measures a vortical pressure field at a first axial location along the pipe and provides a first pressure signal indicative of said vortical pressure field; and

a second filter which measures said vortical pressure field at a second axial location along the pipe and provides a second pressure signal indicative of said vortical pressure field;

a signal processor, responsive to said first and said second pressure signals, which provides a velocity signal indicative of a velocity of the said vortical pressure field moving in the pipe.

2. The apparatus of claim 1 wherein said velocity signal is related to a velocity of said fluid moving in said pipe.

3. The apparatus of claim 1 wherein said velocity signal is indicative of the velocity of said fluid moving in said pipe.

4. The apparatus of claim 1 further comprising a volumetric flow meter wherein said signal processor provides a flow signal indicative of the volumetric flow rate of said fluid flowing in said pipe.

5. The apparatus of claim 1, wherein said first and said second filters filter out wavelengths associated with an acoustic pressure field and passes wavelengths associated with said vortical pressure field.

6. The apparatus of claim 5, wherein said first filter comprises a first spatial filter; and said second filter comprises a second spatial filter.

7. The apparatus of claim 6, wherein:

said first spatial filter comprises at least a first and a second unsteady pressure sensors disposed a predetermined first distance apart from each other; and

said second spatial filter comprises at least a third and a fourth unsteady pressure sensors disposed a predetermined second distance apart from each other.

8. The apparatus of claim 7 wherein said at least one of said pressure sensors comprises a fiber optic pressure sensor.

9. The apparatus of claim 1 wherein said signal processor comprises logic which calculates a cross-correlation between said first and said second inhomogeneous pressure signals and provides a time delay signal indicative of the time it takes for said vortical pressure field to move from said first location to said second location.

10. The apparatus of claim 9 wherein said signal processor comprises logic responsive to said time delay signal which provides an inhomogeneous velocity signal indicative of the velocity of said vortical pressure field moving in said pipe.

11. The apparatus of claim 9 wherein said signal processor comprises logic responsive to said time delay signal which provides said velocity signal indicative of the velocity of said fluid moving in said pipe.

12. A method for use in an industrial process for measuring a velocity of a fluid moving in a pipe, the method comprising:

a) measuring a vortical pressure field at a first location along the pipe and providing a first vortical pressure signal indicative of said vortical pressure field;

b) measuring said vortical pressure field at a second location along the pipe and providing a second vortical pressure signal indicative of said vortical pressure field, said first and said second locations being an axial distance apart; and

c) calculating the velocity using said first and said second vortical pressure signals.

13. The method of claim 12, wherein said calculating step (c) comprises:

d) calculating a cross-correlation of said first and said second pressure signals to obtain a time delay signal indicative of the time it takes for said vortical pressure field to move from said first location to said second location.

14. The method of claim 13, wherein said calculating step (d) comprises:

e) calculating a velocity signal from said time delay signal.

15. The method of claim 14, wherein said calculating step (e) comprises:

f) dividing said axial distance between said measurement locations by said time delay signal.

16. The method of claim 12 wherein:

said measuring step (a) comprises:

measuring a first unsteady pressure and a second unsteady pressure;

subtracting said second unsteady pressure from said first unsteady pressure to form said first vortical pressure signal; and

said measuring step (b) comprises:

measuring a third unsteady pressure and a fourth unsteady pressure; and

subtracting said fourth unsteady pressure from said third unsteady pressure to form said second vortical pressure signal.

17. The method of claim 12 wherein:

said first vortical pressure signal is indicative of wavelengths associated with a vortical pressure field and not associated with an acoustic pressure field at said first location; and

said second vortical pressure signal is indicative of wavelengths associated with said vortical pressure field and not associated with an acoustic pressure field at said second location.

18. An industrial process control system for controlling a velocity of a fluid in an industrial fluid process, said system comprising:

a pipe having at least one fluid flowing therein;

a first filter which measures a vortical pressure field at a first axial location along the pipe and provides a first pressure signal indicative of said vortical pressure field; and

a second filter which measures said vortical pressure field at a second axial location along the pipe and provides a second pressure signal indicative of said vortical pressure field;

a signal processor, responsive to said first and said second pressure signals, which provides a velocity signal indicative of a velocity of the said vortical pressure field moving in the pipe; and

a control device receiving said velocity signal and capable of controlling said velocity of said fluid to a predetermined level.